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ARTHROPOD ENEMIES OF THE LODGEPOLE NEEDLE MINER, *RECURVARIA MILLERI* BUSCK

(Lepidoptera:Gelechiidae)

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The lodgepole needle miner, *Recurvaria milleri* Busck, has many natural enemies. Studies have shown that the most numerous, in terms of kinds and numbers, are other arthropods. The majority of these are either parasitic or predaceous insects, but some are predaceous mites and spiders. In California, where the needle miner is a major pest of lodgepole pine, its arthropod enemies are important because of the part that they may play in controlling outbreaks.

Natural enemies of the needle miner have been studied in conjunction with other biological investigations of outbreaks over the past 40 years. These studies have shown what kinds of arthropods parasitize or prey upon the needle miner, especially during the larval and pupal stages. This paper contains a compilation of the species of insects, mites, and spiders recorded through 1956 as natural enemies of this forest pest. The exact role of each is not well known, but altogether they probably exert an important influence on needle miner populations.

The studies on which this paper is based have been made in areas where needle-miner outbreaks were in progress. The principle outbreaks have been in the lodgepole pine forests in Yosemite National Park on the headwaters of the Tuolumne River, Tuolumne County, and the Merced River, Mariposa County. There have been three periods of outbreaks in these forests since 1910. The first extended from about 1910 to 1922; the second from about 1933 to 1941; the third started in 1947 and was still active in 1957.

The first published records on natural enemies of the lodgepole

¹ Maintained at Berkeley, California, in cooperation with the University of California.

needle miner are of parasites discovered by Patterson (1921) during studies conducted between 1917 and 1919. Yuill² found several more parasitic species in 1937 and later attributed a sudden decline in needle-miner populations to parasitism. More recently, McLeod (1951) published additional information on the parasites of this insect.

Since 1954, investigations on the natural enemies of the needle miner have been intensified, and many additional parasitic species have been discovered. The present list of species known or suspected to be parasites includes representatives of 14 families and 41 genera. Most of them belong to the order Hymenoptera; a few to Diptera.

The only records of predators are those obtained in the most recent studies. Only one of the predaceous species is an insect, belonging to the order Diptera. Of the others, two are mites (Acarina) and the remaining two are spiders (Araneida).

Table 1 contains a list of the arthropod enemies of the lodgepole needle miner.³ The list is divided into four groups, and in each group the species are listed phylogenetically. The first group includes only parasites that have been reared from needle miner larvae and pupae, leaving no doubt as to their direct association with the host. Some of the species in this group, however, may be hyperparasitic. The next two groups have a more remote association with the host. The second group includes species reared from lodgepole pine foliage infested with needle miner larvae and pupae. The third group includes parasitic species collected near lodgepole pines infested with needle miners. Both of these groups contain species that are probably needle miner parasites, but convincing evidence of this fact is lacking since they were not reared specifically from this host. The fourth group consists of predators, mainly arthropods other than insects found feeding upon needle miner larvae.

² Yuill, J. S. Life history and control of the lodgepole pine needle miner, *Recurvaria milleri* Busck, in Yosemite National Park. Season of 1938. Forest Insect Laboratory, Berkeley, Calif. (Manuscript report) February 3, 1939.

³ The assistance of the Insect Identification and Parasite Introduction Section, Entomology Research Division, Agricultural Research Service, U. S. Dept. of Agriculture, is acknowledged in identifying this material. Identifications were made by specialists whose names appear in the table.

Table 1.—Parasites and predators of the lodgepole needle miner

ORDER & FAMILY	GENUS & SPECIES	DETERMINED BY
<i>Species reared from needle-miner larvae or pupae</i>		
HYMENOPTERA		
BRACONIDAE		
	<i>Meteorus</i> n. sp.....	C. F. W. Muesebeck '56
	<i>Apanteles californicus</i> Muesebeck.....	" "
ICHNEUMONIDAE		
	<i>Scambus aplopappi</i> (Ashmead).....	R. A. Cushman '36
	<i>Itoplectis behrensii</i> (Cresson).....	(Muesebeck et al, 1951)
	? <i>Phaeogenes</i> n. sp. "Probably represents a new genus & species".....	L. M. Walkley '56
EULOPHIDAE		
	<i>Sympiesis</i> sp.....	B. D. Burks '56
	<i>Dicladocerus</i> n. sp.....	" "
	<i>Zagrammosoma americanum</i> Girault.....	" "
ENCYRTIDAE		
	<i>Copidosoma</i> sp.....	" "
PTEROMALIDAE		
	<i>Amblymerus</i> spp.	" "
	<i>Hypopteromalus</i> sp.....	" "
CHALCIDIDAE		
	<i>Spilochalcis side</i> (Walker).....	" "
<i>Species reared from needle-miner-infested foliage</i>		
HYMENOPTERA		
BRACHONIDAE		
	<i>Aphidius varigatus</i> Smith.....	C. F. W. Muesebeck '56
	<i>Eubadizon</i> Probably n. sp.....	" "
	<i>Apanteles alticola</i> (Ashmead).....	" "
ICHNEUMONIDAE		
	<i>Scambus hispae</i> (Harris).....	R. A. Cushman '18
	<i>Cremastus evetriae</i> Cushman.....	" "
	<i>Itoplectis conquisitor</i> (Say).....	L. M. Walkley '56
	<i>Hemiteles</i> sp.	" "
	<i>Horogenes</i> sp.	" "
TRICHOGRAMMATIDAE		
	<i>Trichogramma</i> sp.....	A. B. Gahan '36
EULOPHIDAE		
	<i>Sympiesis</i> n. sp.....	B. D. Burks '56
	<i>Tetrastichus</i> sp.	" "
	<i>Zagrammosoma</i> n. sp.....	" "
	<i>Chrysocharis</i> n. sp.....	" "
	<i>Derostenus</i> sp.	" "
	<i>Diaulomorpha</i> n. sp.....	A. B. Gahan '36
	<i>Cirrospilus flavaviridis</i> Crawford.....	" "
	<i>Achrysocharoides</i> n. sp.....	" "
	<i>Euderus</i> sp.	" "

ORDER & FAMILY	GENUS & SPECIES	DETERMINED BY
THYSANIDAE		
	<i>Thysanus</i> sp.....	B. D. Burks '56
ENCYRTIDAE		
	<i>Aphycus</i> sp.	" '53
	<i>Blastothrix longipennis</i> Howard.....	" "
	<i>Lyka</i> sp.	" '52
CHALCIDIDAE		
	<i>Spilochalcis albifrons</i> (Walsh).....	" '55
DIPTERA		
EMPIDIDAE		
	<i>Tachydromyia</i> sp.....	P. H. Arnaud '56
CHAMAEMYIIDAE		
	<i>Leucopis</i> sp.....	C. W. Sabrosky '53
	<i>Species collected in needle-miner-infested stands</i>	
HYMENOPTERA		
ICHNEUMONIDAE		
	<i>Campoletis</i> sp.....	L. M. Walkley '56
MYMARIDAE		
	<i>Ooctonus</i> sp.....	B. D. Burks '56
	<i>Polynema</i> sp.	" "
EULOPHIDAE		
	<i>Tetrastichus silvaticus</i> Gahan.....	B. D. Burks '56
ENCYRTIDAE		
	<i>Syrphophagus</i> sp.	" "
TORYMIDAE		
	<i>Torymus</i> sp.	" '53
PTEROMALIDAE		
	<i>Tridymus</i> sp.	" '56
	<i>Spintherus</i> sp.	" "
EURYTOMIDAE		
	<i>Eurytoma</i> sp.	" "
PLATYGASTERIDAE		
	<i>Platygaster</i> sp.....	C. F. W. Muesebeck '56
SPHECIDAE		
	<i>Xylocelia</i> sp.....	K. V. Krombein '56
	<i>Passaloecus mandibularis</i> (Cresson).....	" "
	<i>Species found feeding on needle miner larvae</i>	
DIPTERA		
EMPIDIDAE		
	<i>Euthyneura</i> sp.....	P. H. Arnaud '56
ACARINA		
ANYSTIDAE		
	<i>Anystis</i> sp.....	E. W. Baker '57

ORDER & FAMILY	GENUS & SPECIES	DETERMINED BY
ERYTHRAEIDAE		
	<i>Balaustium</i> sp.	“ “
ARANEIDA		
THOMISIDAE		
	<i>Misumenops</i> sp.	R. E. Crabill, Jr. '57
SALTICIDAE		
	<i>Sitticus</i> sp.	“ “

Copidosoma sp. is the only parasite listed in this table which is believed to attack the egg. No parasites or predators have been observed to attack the adult stage of the needle miner.

The value of the different species as control agents has not been carefully determined, but some observations on this point have been made. Patterson (1921) credited 12 per cent of the needle-miner parasitism in 1919 to *Eutelus*⁴ n. sp., *Copidosoma* sp., *Epiurus*⁴ sp., *Aethecerus* n. sp., *Apanteles* n. sp., *Habrocytus* n. sp., and an unnamed eulophid. In 1939 Yuill² reported the most common parasites as *Apanteles californicus* Mues., *Amblymerus* n. sp., *Neoderostenus*⁴ n. sp., and *Phaeogenes* n. sp. McLeod⁵ reported these same four parasites by relative abundance in rearings made in 1949. He found that *Apanteles* sp. was most numerous, *Amblymerus* sp. next, *Phaeogenes* sp. third, and *Neoderostenus* sp. fourth. However, in material reared in 1951, McLeod reported that *Amblymerus* sp. was most numerous, *Di cladocerus* sp. second, *Apanteles* sp. third, and *Neoderostenus* sp. fourth. Since 1954 the five most common parasites of the needle miner, judged from the consistency with which they have occurred in rearing by the senior author, have been *Apanteles californicus* Mues., *Sympiesis* sp., *Di cladocerus* sp., *Zagrammosoma americanum* Gir., and *Copidosoma* sp.

Parasite species that have occurred most consistently during the last two outbreak periods (1933–1941; 1947 to this writing (1957)) are listed separately in table 2. Four of them—*Apanteles californicus* Mues., *Scambus aplopappi* (Ashm.), *Copidosoma* spp., and *Amblymerus* spp.—also were taken during the previous outbreak (Patterson, 1921).

⁴ Synonymy: *Eutelus* = *Amblymerus*; *Epiurus* = *Scambus*; *Neoderostenus* = *Achrysocharoides*.

⁵ McLeod, J. H. Excerpt from November 1951 monthly report of the Biological Control Investigations Laboratory, University of British Columbia, Vancouver, B. C. (Manuscript report)

Table 2.—Parasites taken most often in latest two needle-miner outbreaks

ORDER & FAMILY	GENUS & SPECIES	Number times collected		
		1931-37	1953-56	Total
HYMENOPTERA				
BRACONIDAE				
	<i>Apanteles californicus</i> Muesebeck.....	4	1	5
ICHNEUMONIDAE				
	<i>Scambus aplopappi</i> (Ashmead).....	3	0	3
EULOPHIDAE				
	<i>Sympiesis</i> sp.	1	3	4
	<i>Di cladocerus</i> sp.	2	3	5
	<i>Zagrammosoma americanum</i> Girault	2	2	4
	<i>Tetrastichus</i> spp.	2	3	5
ENCYRTIDAE				
	<i>Copidosoma</i> spp.	1	4	5
PTEROMALIDAE				
	<i>Amblymerus</i> spp.	3	3	6
CHALCIDIDAE				
	<i>Spilochalcis</i> spp.	2	2	4

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A belated correction: *Sphinx* ("Spinx") *sequoiae* Bdv. Under "Notes on the Larvae of Certain Lepidoptera," 1905, *Ent. News*, XVI: 153, I described what I thought to be the egg, larva and pupa of this rather small gray sphinx moth, from Shasta County, California. But the pupa, or pupae did not hatch. What were probably described were the early stages of *Smerinthus jamaicensis* Drury.

As far as I am aware, the early stages of *Sphinx sequoiae* are still unknown, but its caterpillar may well feed upon one of the coniferous trees.—FRANCIS X. WILLIAMS.